Pre-Lithiation of High-Capacity Battery Electrodes

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Project ID
bat 272

Overview

Timeline

- Start: Oct 1, 2018;
- End: Sep 30, 2022;
- Percent complete: 90%

Budget

- Total project funding
- $1800k from DOE
- FY21 $500k; FY22 $500k

Barriers: Low Coulombic efficiency; Low capacity; High chemical reactivity

Partner: BATT program PI's; SLAC: In-situ X-ray; Amprius Inc.; Stanford: Zhenan Bao

Relevance

- Increase first-cycle Coulombic efficiency via anode prelithiation.
- Design prelithiation reagents of high stability in both dry air and ambient air conditions to prelithiate all kinds of anodes
- Design prelithiation process to optimize the reaction process.

Approach

Prelithiation reagents design and synthesis

- Design prelithiation reagents stable in the dry and ambient air condition by exploring inorganic and organic coatings.
- Design prelithiation reagents with tunable prelithiation capacity and no excess lithium concern.

Prelithiation process design

- Utilize pressure to achieve heat-free and solution-free prelithiation.
- Design solution-free in-situ prelithiation process that prelithiates electrodes after cell assembly, preventing cell reassembly.

Electrochemical testing and structural characterization

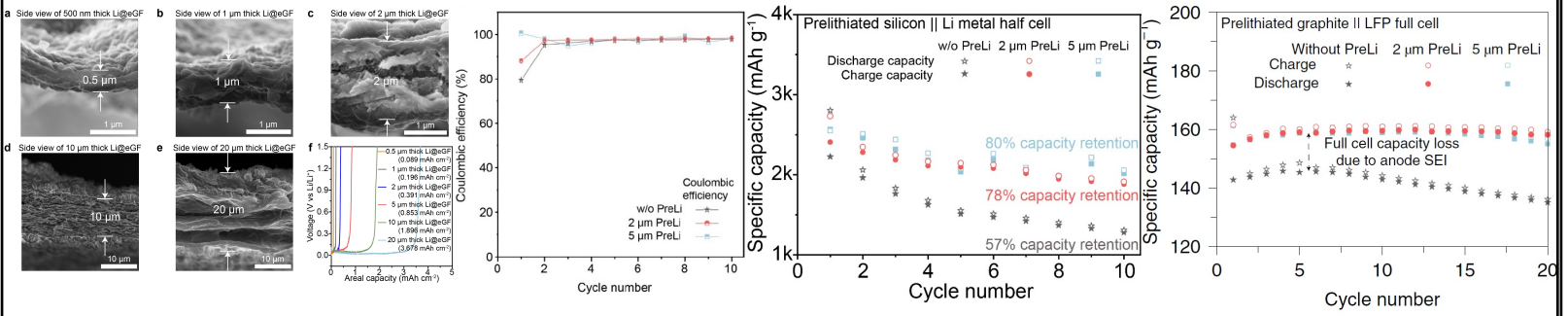
- Ex-situ transmission electron microscopy
- Ex-sity scanning electron microscopy,
- Coin cells and pouch cells, and a series of electrochemical tests.

Milestones

Month/year	Milestones
9/2021	Demonstrate the role of ultra-thin lithium foil prelithiation to improve good cycle capacity retention in full battery. (Completed)
12/2021	Demonstrate a new solvent-free dry prelithiation strategy through in situ prelithiation. (Completed)
3/2022	Demonstrate the in situ prelithiation strategy can delicately control the prelithiation amount. (Completed)
6/2022	Demonstrate the in situ prelithiation strategy can achieve uniform prelithiation. (Completed)
9/2022	Investigate the prelithiation kinetics in the in situ prelithiation strategy. (On schedule)

Technical Accomplishments

Design ultrathin rGO hosted Li foils (Li@eGF) for prelithiation



- Ultrathin Li@eGF foils of thickness from 0.5 -20 μm are produced, which provide ideal prelithiation capacity.
- Prelithiation with Li@eGF improves initial CE of Si anodes to nearly 100%, as well as Si cyclability.
- Prelithiation with Li@eGF improves full cell capacity retention.

Yi Cui, Nature Energy 6.8 (2021): 790-798.

Collaboration

Prof. Zhenan Bao, Stanford University; Prof. Michael F. Toney, Stanford University; Amprius Inc.

This presentation does not contain any proprietary, confidential, or otherwise restricted information

Proposed Future research

- Explore new prelithiation reagents with tunable and fit capacity.
- Explore other prelithiation strategy with high efficiency and controllable prelithiation amount.
- Understand the interaction between prelithiation reagents and the electrolyte by cyro-EM and other advanced characterization techniques.
- Develop new in situ techniques to reveal the prelithiation kinetics.

Any proposed future work is subject to change based on funding levels.

Summary

- rGO hosted ultrathin Li foils (Li@eGF) are developed as new prelithiation reagents.
- This ultrathin Li foil provide ideal prelithiation capacity without the excess Li concern.
- Li@eGF also serves as a protective layer to reduces cracks in Si electrodes and improves Si cyclability.
- Prelithiation with Li@eGF compensates the initial battery capacity loss and increases battery capacity retention.